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The following suggestions of a friend have been too long delayed.

For the American Railroad Journal and Mechanics' Magazine.

In some of my operations it has occurred to me that columns made up of wrought iron round rods, could be usefully applied in several instances with good effect, say in store fronts, piazzas, verandahs, &c.; the idea will present itself most forcibly by comparing such columns with the "*open connecting rods*" of the steam engine. Light houses constructed on this principle, would afford very little resistance to either wind or wave, and would facilitate their erection in situations very much exposed, even upon breakers.

I have observed that cleaning the glass of the surveying compass on a cold day with a silk handkerchief, charges the glass with electricity, and in one instance, caused one end of the needle to rise into contact with the glass; may not the different states of excitement in the glass be the cause of the variation made by several instruments?—known as instrumental variation, not the "magnetic."

In Simms' treatise, some importance is attached to the method proposed of reading off and noting the indications of the level at the instrument and not at the staff as formerly. It appears to me that such an operation would be greatly facilitated by constructing the level so that it could be raised without derangement of the bubble, to coincide with the sub-divisions on the staff,—with a vertical motion of an inch at the instrument, the sub-divisions of the staff need not be less than ½ inches, and they would thus be more readily recognized at a considerable distance.

GEORGIA.

WISCONSIN RAILROAD.

We cheerfully give place to the following letter and memorial, and shall be pleased if in so doing we contribute to the success of the work in contemplation.

For the American Railroad Journal and Mechanics' Magazine.

SINIPEE, Grant County, Wisconsin,
October 18th, 1839.

Gentlemen—I have the honor to enclose a copy of a Railroad Memorial, to which I respectfully solicit your attention.

I am Gentlemen, very respectfully,

JOHN PLUMBE, JR.,

Chairman Wisconsin R. R. Committee Correspondence.

TO THE HONORABLE THE SENATE AND HOUSE OF REPRESENTATIVES OF THE UNITED STATES IN CONGRESS ASSEMBLED.

The undersigned, citizens of   respectfully represent:

That they deem the importance of a Railroad connexion between Lake Michigan and the Mississippi river, passing entirely across the Territory of Wisconsin, to be of such vast NATIONAL magnitude, as to entitle the project to the continuance of the most favorable regard of your Honorable Bodies, in appropriating the necessary means for its immediate completion.

Already has individual enterprise extended an almost entire chain of Railroads from the eastern limits of the Union to the shore of Lake Michigan; which will furnish a direct line of the most rapid and never interrupted communication from Maine to Iowa, with the single exception of about one hundred and fifty miles within the boundaries of Wisconsin; whose surface is so admirably adapted to the formation of Railroads as to require the least conceivable expenditure of labor in their construction.

If the benefits to be derived from the completion of this work were such as to accrue to Wisconsin and Iowa exclusively, it is confidently believed that the liberality of Congress would still afford to a considerable extent, at all events, the necessary aid to carry it into effect, if only in justice to these Teritories, in consideration of the large amount they have contributed to the receipts of the Treasury, in payment for lands and the tax upon lead.

But, when the NATIONAL importance of the improvement is taken into view, it would seem as if the enlightened wisdom of your patriotic Bodies could not possibly consent to retard the prosperity of our beloved country, by withholding the comparatively trifling appropriation which would secure to the Union, *generally*, advantages such as human capacity cannot estimate, but whose constantly increasing magnitude must continue to endure while America retains her name.

This Road would afford to the United States a most efficient and economical check upon the vast hordes of savage Indians, congregating to so formidable an extent upon her exposed and widely spread northwestern frontier, and would prove of paramount utility in the not impossible event of foreign invasion: and these considerations alone, aside from all others, would, we concive, be sufficient, in themselves, to insure to our memorial compliance with its prayer.

It would furnish the most desirable means of transporting her mails for an almost boundless extent of the fairest portion of our happy land, now rapidly filling up with enterprising and intelligent citizens; as well as of conveying her troops, military stores, and munitions of war, for the various permanent garrisons now existing, and to be farther increased, in the Indian country.

It would constitute a permanent link in the great Oregon Railroad, which the indomitable spirit of American enterprise will, at no distant day, exhibit to an admiring world, connecting our Atlantic with our Pacific sea-board.

But, independently of all National and prospective considerations, which so forcibly prove the importance of constructing the Wisconsin Railroad without any delay, the commercial business, alone, of the Upper Mississippi country would, beyond all question, afford a sufficient amount of transportation to render it a source of immediate profit, as soon as completed. Your memorialists will, therefore, conclude by respectfully expressing their firm conviction, that further argument would be superfluous in securing the object of their present solicitude.

ECONOMY OF FUEL.

(Continued from page 304.)

It would seem, therefore, that there can no longer be any excuse for a continuance of the wasteful practice of consuming the small coal at the pit's mouth, to say nothing of that which is thrown aside as useless in the pits themselves, and which never sees the light, since by this invention, that which was before considered as mere refuse, has acquired a certain fixed value, and it is to be hoped that this disgraceful practice is now completely put a stop to.

Of the various substances which have been used as a substitute for coal, where that article is scarce, peat stands foremost in the list. Our peat or turf beds are of great extent, especially in Ireland, and contain a valuable reserve of fuel, applicable, when properly prepared, to all the purposes of mining or manufactures. An important feature in this fuel is, that, unlike coal, of which we know of no instance of reproduction, turf or peat is continually being reproduced; in fact, in many parts of England the growth exceeds the consumption, and consequently the turf beds in those places are on the increase.

Before being used, however, this fuel requires to be thoroughly dried by exposure to the sun and air, during which process it contracts considerably in its dimensions, and increases in density, so much so as frequently to aproach in hardness and appearance to common coal. This, however, is only the case with bog peat, or that which is saturated with water, but turf may be made so by placing it at first in running water, and then suffering it to dry. Artificial means have been used for compressing peat;—and a machine for this purpose, invented by a patriotic nobleman, Lord Willoughby de Eresby, has been attended with complete success. The chief advantage of this invention is the great saving of time effected in the conversion of the wet peat into a solid dry fuel.

In France peat is extensively employed, both for domestic purposes, and in the different metallurgic processes, after having been converted into a charcoal by placing the peat to be carbonized in a furnace, where it is ignited, and smothered up in the usual manner. The iron made with this peat charcoal is described to be of a superior quality to Swedish iron, being more malleable, and more easily welded, owing, sa it is supposed, to its comparative freedom from sulphur, which is known to exist in large quantities in coal, and which is not completely driven off by its convertion into coke. weld

Very lately this peat coke has been introduced into some of the trans-atlantic steam boats, in combination with a certain proportion of resin. This resin fuel is not used alone, but when about 2½ cwt. of it are mixed with 20 cwt. of coal, a much better combustion of the coal takes place; and the effect is described as being equal to that which would be produced by 27 cwt. of coal. The mode of using it is by throwing it in front of the fire with each charge of fresh coal.

For many years the attention of scientific and practical men has been

directed to a method of using a valuable description of coal, the use of which, owing to its peculiar properties, has been until lately confined within a very narrow compass.

This fuel is the "anthracite," or stone coal of South Wales. Its chief properties consist in its freedom from sulphur or bitumen (being composed wholly of carbon, mixed with a slight proportion of oxide of iron, silex, and alumina,) its great durability and steady heat, burning clearly without smoke or flame. These valuable qualities have long secured to anthracite a very extensive use in the drying of malt in many districts of England, where it is preferred even to coke or charcoal; but it is only within the last few years that it has acquired the high rank of importance, in a national as well as a domestic point of view, which it now possesses.

Dr. Arnott, for whose stoves it is exclusively recommended by him, has declared that it is a blot in the police regulations of London, that all great manufacturers are not confined to the exclusive use of this description of coal, its non-emission of smoke and noxious vapors, tending so much to preserve the purity of the atmosphere in the metropolis. Since, so long back as the reign of Elizabeth, the burning of coal was prohibited in London during the sitting of parliament, lest the health of the knights of the shire should suffer duing their abode in London (so careful was this queen of the health of her subjects;) it is surely incumbent on us in the present day, when from the immense increase of the number of manufactories of every description, the atmosphere of London is never clear from smoke, to pass some legislative enactments to remedy the growing evil. Experiments have satisfactorily proved that anthracite gives out in combustion 30 per cent. more caloric than coke or bituminous coal.

In America, this valuable mineral has been long and extensively employed, not only for manufacturing processes, but also in steam navigation, and for locomotive engines; also for the warming of apartments, and for every other domestic purpose; indeed its cheapness, the intensity and durability of the heat which it produces, together with its perfect safety and freedom from smoke or smell, give it a decided preference over every other species of fuel.

Mines of this coal have for some years been extensively worked in Rhode Island, Massachusetts and other States; but it is in Pensylvania that it is found in the greatest abundance; there the anthracite coal formation covers a tract of country many miles in length and breadth, extending across the two entire counties of Luzerne and Schuylkill. Throughout this region it is obtained with very little labor, being situated in hills from 300 to 600 feet high above the level of the surrounding rivers and canals, and consequently easy of transportation to all parts of the Union. It exists in horizontal beds, from 15 to 40 feet in thickness and covered merely by a few feet of gravelly loam. This coal has been found in several European countries, and exists abundantly in Ireland; but the great supply of anthracite for this country is found in that part of the great coal formation which environs Swansea and Carmarthen bays, and which forms a part of the great coal field of South Wales. Here it exists in immense quantities.

It is, however, but very recently that the attention of engineers has been turned to the use of this fuel for locomotive engines; a short time since, a trial of it was made under the sanction of the directors of the Liverpool and Manchester railway, and the following is the report of the talented engineer of that company:—

In the first instance, the engine ran out with a load about six miles, and the coal was found to do very good duty without any difficulty being expe-

rienced, either with the tubes, or in the getting up of the fires. The engine brought back a load of coal wagons, from the Hetton Colliery, and acquired a speed of 21 miles an hour, thus loaded. Another trial was made in the evening with the same engine for the whole distance to Manchester, taking five loaded wagons; the journey was performed in one hour and twenty-nine minutes. The consumption of anthracite was only $5\frac{1}{2}$ cwt. although a large portion was wasted from the fire bars being too wide apart for the economical use of this fuel. The engine would have used upwards of $7\frac{1}{2}$ cwt. of coke for the same journey, with the same load."

The trial with locomotives then, must be considered quite conclusive, and the next object most deserving the attention of practical men, is the application of anthracite to the marine engines of sea going steam vessels. When it is considered that 30 per cent. at least is saved in the stowage by this description of fuel, the importance of this subject will be at once made manifest, and there can be little doubt that with certain trifling alterations, in the construction of the boiler and furnace, the object may be attained.

It is not surprising that, considering the importance which has of late years been attached to every means of economising fuel, the attention of scientific and practical men should have been directed to various methods for accomplishing this object, and numerous alterations and improvements have been effected in the furnaces and boilers of steam engines, by which the heat given forth by combustion has been made more available, but much remains yet to be done, as a very large quantity of heat is lost, from the smoke which is wasted, the heat which passes up the chimney, and from the imperfect manner in which coal is generally consumed.

An ingenious invention for intercepting and returning to the boiler fire, a large portion of the heat which would otherwise pass up the chimney and be dissipated, was brought into notice in England a few years ago, by a German named Schauffelen, and was denominated "Schauffelen's Hot-air Furnace Feeder." The invention consists in the use of a number of metal pipes or tubes open at the bottom, but closed at the top. These pipes are placed in a vertical position in the chimney, and the air in passing through them becomes heated from the current of hot air passing up the chimney, and in this state is supplied to the fire, all ingress of cold air being carefully excluded by means of closely fitting iron plates attached to the ash pit.

With respect to the amount of saving in fuel effected by this apparatus, it is stated by the inventor as varying from 20 to 25 per cent., when in good working order, and its advantages are not entirely confined to a saving of part of the heat which would otherwise escape up the chimney, but moreover, a more intense heat in the fire place is maintained, and consequently a more complete combustion of the fuel and smoke takes place.

Another invention of great simplicity for the economy of fuel, and the prevention of smoke, is described in the *Mining Review* of August 31, 1838. The process consists merely in the introduction into the furnace of steam in small quantities, through a tube taken from the boiler, and discharged over the fuel at any convenient place. The end of the tube should be formed with a fan-shaped termination, perforated with minute apertures so as to throw the steam in small jets down upon and over the fire. One effect produced is *the absolute prevention of smoke*; another, the operation of the fire is fully doubled, and the steam employed, itself consumed. The employment of steam also greatly increases the draft of the chimney.

"It is held by competent authorities, that one pound of Newcastle coal (supposing the whole of the heat emitted by its combustion was made available,) should drive off in steam 14 lbs. *of water*. This however, is

very far beyond what is actually done in practice, by ordinary steam engine boilers. Indeed it is found by experience to require as much as one pound of coal to convert into steam four to six pounds of water, six pounds being considered a high product. By means of Mr. Ivison's method however, it is found that an average of thirteen pounds of water are evaporated by one pound of ordinary Scotch coal, thus more than doubling the results heretofore obtained, and consequently effecting a saving of upwards of 50 *per cent.* of fuel.—*Mining Review,* August 31, 1838.

One great source of loss of heat and consequently of fuel, in most large establishments where steam power is extensively employed, arises from the radiation of heat which is constantly taking place from the boiler, where, as is most frequently the case, no means are adopted for preventing it. When we consider the large surface that is exposed by each steam engine boiler, and that from this there is continually going on a powerful radiation of heat into the surrounding atmosphere, it is evident that the loss from this source alone, must be immense. If, therefore, this large body of heat can by any means be intercepted and returned to the boiler, it is clear that there will be a saving of all that fuel which was required to raise that heat in order to disperse it again. The method of doing this is simple, and attended with very little expense. All that is necessary to be done is to surround the boiler with a jacket or casing of wood or brick, leaving a space of a few inches between it and the boiler, to be filled with some substance which is a slow conductor of heat. The material that has been employed for this purpose, is a mixture of sawdust and ashes, rammed in so as to lay close to every part of the boiler; and where this system is carried to its full extent. which is in the large pumping engines, used in the mines in Cornwall, not only the boiler, but also the cylinder and steam pipes, are in the Cornish engines, completely encased with some non-conducting material, which renders the engine and boiler houses as cool as the interior of a dwelling house, where there are only ordinary fires—a sure proof that little or no heat is lost by radiation.

Another proof of the efficacy of this system is, that even after the engine has been standing still for 12 hours very little heat is lost, and if it is necessary to start it suddenly, as in case of emergency, scarcely any time is lost in raising the steam, and *one fourth* the fuel only is required; whereas, in the common engines and boilers, where every vessel containing steam is exposed to the atmosphere, it takes from 20 minutes to half an hour, firing hard, to raise the steam to the requisite pressure.

It would occupy too much time, and swell these remarks to too inconvenient a length, were I to enter into the details of all the inventions that have been proposed for economising fuel, although many of them are of great value, as their general adoption sufficiently testifies; whilst others either from the complexity of their parts, or their general inapplicability, have soon fallen into disuse. It is hoped, however, that sufficient has been said in this paper, to point out the great importance of the subject, and to show, that however much may have been hitherto done, much yet remains to be done, before we can confidently state that the whole *inherent virtue* residing in one pound weight of coal or other fuel, is made available.

Frederick S. Peppercorne.

April 8, 1839.

A New Enterprize.—The Philadelphia Inquirer states that Mr. Jacob Ridgway has in contemplation, early next spring, to run a line of steamboats, stages and locomotives, between Philadelphia and New York, via. Trenton and New Brunswick, at the price of two dollars for the whole

route. The stage department is to be under the superintendence of Mr. Reeside.

ON CERTAIN FORMS OF LOCOMOTIVE ENGINES.—BY EDWARD WOODS.

Among the causes which contributed to the success of the earlier experiments in locomotion upon the Liverpool and Manchester Railway, the method of generating steam deserves the most prominent place. The chamber or fire-place, containing a large mass of fuel surrounded on every side by water, with its appendage of tubes, or small flues disposed in the interior of the boiler, and exposing a large surface to contact of the heated air, was well calculated to turn to good account whatever heat the fuel during its combustion might produce.

It is however by no means improbable that this ingenious contrivance would have failed in securing the end proposed, and would perhaps even have been abandoned, but for the judicious application of a discovery, then only recently made, the practicability of producing a strong artificial draught of air through the fire, with facility and economy, by the exhausting power of a jet of waste steam directed upwards into the chimney.

The powers of the arrangement as thus combined, were attested by a very rapid generation of steam, and by the consequent attainment of a speed of travelling nearly threefold greater than any previous system had accomplished.

It is therefore less a matter for surprise that few attempts should have been made to improve upon so simple and effective a form of boiler, while material variations were taking place in the outward plan and disposition of the machinery.

Under the hands of different builders of locomotive engines for railways, the boilers have been subject to various slight modifications; but, whether fire boxes have been constructed of iron or of copper, whether square with stays, or round without stays, whether the tubes have been more or less in number, of larger or smaller size, or of different material, the combination of both, as it existed in the earliest engines, has been adopted on every line of railway where the transport of passengers is a primary object.

The case has been otherwise with the machinery destined to render available the resources which the boiler so abundantly provides; and builders, actuated by caprice and the desire of differing from competitors, or more laudably influenced by the indications of experience, or by some happy effort of their own ingenuity, have departed widely from the first models submitted for their imitation.

Many crude schemes have successively appeared before the public, and have been deservedly rejected; many useful applications have withstood the test of time, and remained embodied in the machines to whose utility they have subserved. But although practical and scientific men are as equally agreed in condemning some inventions, as they are in approving others, there exists a class of forms, respecting the individuals of which, a great and reasonable difference of opinion is still entertained.

It is proposed in the present paper to state, with regard to a few of such forms, some results which the working of the Liverpool and Manchester line has afforded, and to consider what general arrangements of the parts of the locomotive engine are most conducive to its efficiency and durability, under the requirements of a railway intended for the transport of heavy loads at high speeds. The leading features into which a discussion upon the subject may with propriety resolve itself, bear reference to the relative superiority of—

Engines with four and with six wheels;
Engines with inside and with outside framings;
Engines with crank axles and with outside crank pins;
Engines coupled and uncoupled; and the forms arising out of different combinations of these with each other.

Engines with four or with six wheels and inside or outside framings.

The engines at first introduced upon the Liverpool and Manchester line of railway were found to be much too slightly constructed for sustaining the shocks and strains to which their high velocities, and the inequalities of the road, continually exposed them; so that after a service, short in its duration, but actually and unexpectedly great in respect of the distances travelled, each individual engine required and underwent a thorough and general repair. The nature of such repair consisted principally, at least as far as mechanical causes contributed to deteriorate the machine, in the substitution of greater strength and more approved forms of material, with a disposition and mode of connection of the parts, better adapted to resist frequently repeated and periodical concussions.

Thus the outer and inner framings were stayed in various directions; wooden wheels were replaced with iron ones; crank axles were constructed with almost double the original quantity of material; pistons, piston-rods, connecting rods and brasses were proportionally strengthened, until, finally, little remained of the old engine but its boiler and cylinders.

Such extensive alterations naturally occasioned a considerable addition to the weight, and it was found accordingly, that the engines first operated upon, built after the form of the "Rocket," and originally weighing from four and a half to five tons, became at least two tons and a half heavier than before; while others subsequently introduced, and known under the denomination of the "Planet" class, were increased in nearly the same proportion arriving ultimately at no less than ten tons.

However conducive to the durability of the engine these alterations might prove, the effect of greater weight moving upon the road, could not be otherwise than highly prejudicial. The road was in fact formed of rails intended to support a moving mass of not exceeding four tons and a half distributed upon four wheels.

Indeed the terms prescribed in the competition for the premium publicly offered in 1329, shortly before the opening of the railway, required of the builder or inventor who proposed to submit his engine for trial, that it should be supported upon not less than *six* wheels, if the weight exceeded *four and a half*, or fell short of *six* tons; six tons, inclusive of the complement of coke and water, being the extreme limit allowable.

It was soon found impracticable to maintain the road in a state of efficient repair, when subjected to the influence of such disproportionate weights, rolling at great speeds, and frequently acting with the full force of impact due to the velocity of descending deflected portions of the rails. The rails were seriously bent, continually becoming loose in their supports, and frequently broken.

To return to the lighter form of engine, had it been even practicable, would not have been desirable; the only alternative that remained, and of which the adoption was ultimately decided upon, being to relay the whole line with stronger rails, and in the mean time to apply precautionary measures to lessen the evils adverted to. Such measures were rendered indispensably necessary by the arrival of some engines of still greater weight than any before in operation.

The most obvious remedies were: first, to place temporary props under

the rails between the points of support, and more especially near the ends of the rails; and secondly, to add a third pair of wheels to the hind part of the framing of the engine. Both these expedients were extensively resorted to. The "Mars" and the "Atlas" first underwent the alteration, followed by the "Titian," "Orion," "Hercules," "Thunderer," "Firefly," "Planet," and others, engines originally provided with only four wheels.

In the structure of engines which have cylinders within the framing, and consequently inside cranks, it is a necessary condition that the centre of the main or crank axle should be placed in a position to allow the crank and connecting rod ends to clear the front of the fire-box during their revolution. This circumstance evidently limits the distance from the crank axle to the centre of gravity, and causes considerably more than half the weight to rest upon this axle, inasmuch as the fire-box, with double casing, fuel, bars, &c., constituting by far the heaviest proportion of the engine within a given length, completely overhangs its centre.

From hence has resulted, during the rapid transit of engines upon an uneven surface, (and no railway has yet been constructed free from inequalities,) a continual vibratory motion in a plane perpendicular to the direction of the axles.

Now as the effect of any downward motion in the vertical plane, or in other words, the amount of injury sustained reciprocally by the engine and the road, is expressed by the velocity which the centre of gravity has acquired in vertical descent, multiplied by the weight of the body, so most injury is received when the wheels of the large axle pass the obstacle, because for any given amount of their depression or elevation, the centre of gravity falls or rises through a greater space. The more equally we can divide the centre of gravity between the bearing lines, and the larger the interval between those lines, the greater becomes the steadiness of the machine. Considerations of this nature are necessarily influenced by the general form and dimensions of the parts to be acted upon.

The established form of the locomotive engine did not so much admit of alteration as of addition, and accordingly the third pair of wheels was placed behind the fire-box, to aid in its support.

The advantages obtained were almost immediately apparent. The engine lost in a great degree its peculiar rocking motion, as also the unsteadiness arising from lateral undulations; which later effect was in like manner attributable to the diminution of the angle of which the oscillations were susceptible. Beside such direct and immediate results, time soon developed further consequences of an important nature. The component parts of the engine remained for a much longer period than before securely united and firm, the fastenings of the tubes became less liable to leak and give way, and the bolts and stays of the framings were less disturbed. Lastly, though not of least importance, an inherent source of safety was superadded, in the diminished liability of the engine to run off the rails in the event of the large wheels or the crank axle breaking. Instances in which this quality has been put to the proof have occasionally occurred. They have invariably demonstrated the high importance of the application as an especial security to passengers and to the attendants; and in consequence the principle introduced was not abandoned, even after the road had been entirely relaid with new rails.

INSIDE AND OUTSIDE FRAMING.

Intimately connected with the safety of railway travelling, and with the mode in which the application of six wheels can be turned to best account, is the often agitated question of an outside framing. It cannot admit of doubt in the mind of any one at all conversant with the properties of machinery, that an axle or shaft

impelled by any given power will revolve more steadily, in proportion as the distance is greater between the bearings, provided at the same time, its form be of strength sufficient to resist deflection. No bearings can be made, or if made, could long continue in strict mathematical adjustment with the axis of motion. Where the power is uniform and acting only from one direction, as in the case of a wheel and axle driven by a strap, or by another wheel, a slight deviation from truth is of comparatively small importance, and in fact occasions no perceptible amount of eccentricity in the motion; but when the impelling power is variable in its action, and not only variable but applied alternately to opposite sides of the axis, the wear of bearings proceeds in a two-fold direction, and the want of accuracy becomes detrimental to the machine.. Were the power (supposed acting periodically on both sides of the axle) constant in its nature, in so far as that at the same moment it only impelled the same side, the axle would simply roll to and fro in its bearings during such periods, accompanied indeed by a slight shock at the moment of reversal, but preserving throughout its parallelism. The case with the locomotive engine is in this respect different. The axle with its double crank is urged by two independent forces, not operating simultaneously but periodically, opposed to each other; and the consequence ensues, that the axle, the wheels, and finally the engine itself, is thrown into a state of vibration, the angle of which is precisely in the inverse ratio of the distances between the bearings. Hence those engines whose bearings are only about four feet asunder, soon acquire play in the brasses, and unless frequently examined and repaired, become unsteady and even unsafe when travelling at rapid speeds.

This consideration (one as I conceive of great importance) does not immediately involve the principle of an outside framing, inasmuch as greater length of axle may be obtained by widening the road, but it has an indirect reference, when the contiguity of bearings is found objectionable, and the width of the way does not admit of alteration. The superior danger of the inside above the outside framed engine, consists in the fact, that should the wheel of the former become loose, or the axle break, the engine would almost inevitably fall over on its side; whereas in the other form of engine placed under similar circumstances, the wheel remains confined within the framing, tending to support the whole, until the attendants shall have been able to arrest the further progress of the train. The application of the outside framing is attended with another advantage, of which the beneficial effects are exhibited in imparting, when properly constructed, a degree of elasticity to the whole machine, tending to equalize and reduce the injurious effect of concussions received during motion upon an uneven plane.

OBJECTIONS TO SIX WHEELS.

The principal objections that have been urged against six wheels are:

1st. That they have less adhesion than four-wheeled engines.

2d. That the axle and the weight of wheels adds to the resistance, and consequently detracts from the available power.

3d. That they cannot traverse curves without increased strain and friction.

I shall offer some observations, seriatim, upon these objections.

With regard to the first, it is perfectly true that the adhesion is less; for adhesion is proportional to pressure or weight, and the same weight supported on four wheels must exert a greater pressure per wheel than when it rests upon six; but the real question to be considered is, whether the *ratio* between the adhesion and the power of the engine is not such as to permit the exertion of that full power in ordinary states of the railway and

under the practical conditions of the traffic. Observations on the working of the Liverpool and Manchester line since the introduction of six wheels, have convinced me of the present sufficiency of adhesion. On referring to the weekly returns of the "late arrivals of coach trains," with their causes, during the year 1837, the following particulars have been extracted of all delays alleged to have arisen from the slipping of the engine wheels. The account stands thus:

In 3640	coach trains (first and second class) despatched from Liverpool to Manchester, the delays by slipping have amounted altogether to	412
In 3640	coach trains despatched from Manchester to Liverpool, the delays by slipping have amounted altogether to .	792
7280	Trains delayed.	1204

Averaging one-sixth of a minute for each train on its trip of thirty miles.

The greatest delays recorded are about 30 minutes, the least 3 minutes;* the trains consisting of six or seven carriages. The time of performing the trip is one hour and a half for a first class, and two hours for a second class train. As the trips are frequently performed in less time, it is but fair to conclude that the actual loss of time by slipping is considerably greater than what is here assigned. I should imagine the real amount to be at least double.

The cases in which trains suffer delay by slipping, form, therefore, rather the exception than the rule, the existing inconvenience might, however, be almost entirely removed by coupling the wheels.

The Liverpool and Manchester engines have undergone little alteration in the ratio of adhesion to power, the power having in most instances remained the same, the weight only being increased, and the surplus weight sustained on an extra support. Engines altogether new are seldom of less weight in proportion to their power than those of the older make, as the "Mars" and the "Atlas."† The usual weight is about eleven tons and a half, and nearly thus divided:

	tons.	cwt.	qrs.
On the fore wheels	4	10	0
——— driving wheels	5	0	0
——— hind wheels	2	0	0
Total . .	11	10	0

Some engines are found frequently more subject to slip than others, although the weights upon the driving wheels have been the same, and the

* It may excite surprise that the delays experienced in the trips from Manchester to Liverpool should exceed those of the trips in the contrary direction. The fact is accounted for by two circumstances, which in any state of the road tend to render the times unequal. The station at Liverpool, from whence the locomotives start, is higher than the terminus at Manchester by 43½ feet. The trips from Liverpool are therefore performed on an average descent of 43½ feet in 30 miles, and those from Manchester on an average ascent of 43½ feet in the same distance. The latter will be thus found to require about 14 per cent. more power than the former for an equal load, or, in other words, the load of the engine is increased, and consequently the tendency to slip. The second circumstance alluded to is the prevalence of westerly winds during a great part of the year. These, by increasing the resistance to be overcome, occasion considerable detention in the aggregate of a year's work.

	tons.	cwt.	qrs.		tons.	cwt.	qr.		tons.	cwt.	qrs.	Increase. tons.	cwt.	qrs.
† Mars, originally	4	15	0	+	2	14	1	=	7	9	1	2	4	1
now	.	.	.		.		.	=	9	13	2			
Atlas, originally,	.	.	.		.		.	=	8	11	2	3	3	3
now	.	.	.		.		.	=	11	15	1			

construction in other respects identical. This is, without doubt, to be attributed to malformation of the springs, and want of due adjustment to the weights they have to support. Our engine builders are remiss in their attention to the subject, and the springs of most new engines have to be taken in pieces and remodelled before they can become thoroughly serviceable. Rapidity of recoil when the wheel passes an obstacle is the point to be aimed at.

To the second objection I do not attach much importance; the additional weight of a pair of wheels, axle, springs, and pedestals, does not exceed 12 cwt., and therefore on a liberal estimate cannot oppose greater resistance than ten or twelve pounds, equal to about $\frac{1}{200}$th of the whole tractive power of the engine, a quantity insignificant when put in competition with any real advantage gained. Some portion of the power of the four-wheeled engine must be expended in the oscillatory motion, as well as in overcoming the friction of flanges continually rubbing against the rail; and such portion would, I conceive, be found even to overbalance the extra resistance of a third pair of wheels.

The third objection, viz, the tendency to strain and the friction in passing round curves, and the difficulty of "taking the points," is prevented by the simple expedient of rendering the pedestals to the axle of the hind wheels very light and elastic, so that they will yield readily sidewise to an impression. For this purpose it is found better to use small wheels, say three feet in diameter, that the plates of the pedestals may be long, and the axles at a considerable distance below the framing. These plates are in some instances carried up on one side only of the frame; the opposite plate is turned underneath, and the whole acquires more flexibility. Such precautions render uncoupled six-wheeled engines capable of traversing safely curves of eight chains radius, at a speed of from 6 to 8 miles an hour; an instance has occured of a short curve of only four chains radius being passed at a slow speed. The common plan of allowing play in the axle journals to meet the difficulty of passing curves, appears to be rather prejudicial than otherwise.

The application of the principle of elasticity should not stop at the hind wheels, but be in fact extended, though in a less degree, to the entire framing. In every railway, *lateral* as well as vertical inequalities exist, which continually drive the engine out of the straight line. The framing, if made pliant and yielding to lateral impulse, will be found to bend slightly, without disturbing the whole mass. The provision is, in fact, tantamount to a secondary and subordinate system of springs, and the engine as well as the road are less deranged, while at the same time an increase of available power is obtained, and the speeds are consequently faster.

Engines possessing only inside framings are evidently unsusceptible of lateral elasticity. Such framings are required, not merely to serve as carriages for the *boiler*, but likewise to sustain many parts of the machinery, a condition absolutely requiring inflexibility. Outside framings act simply as carriages to the boiler, and have no fixed connection with any other part. The machinery in these is attached exclusively to the *boiler*, and is less exposed in that position to casual jolts and strains.

(To be continued.)

THE KILSBY TUNNEL.

The Kilsby Tunnel is about 2,423 yards long, and was intended at first to be formed eighteen inches thick in the brick work; but it was found ne-

cessary to increase this, in most cases to twenty-seven inches. The whole has been built in either Roman or metallic cement.

The works were commenced in June, 1835, by the contractors; but such serious difficulties were met with, at an early stage of the proceedings, that they gave up the contract in March, 1836, and nearly the whole work has been performed by the company. Previous to the commencement of the works, trial shafts were sunk in several parts of the line of the tunnel, in order that the nature of the ground through which it would have to pass might be ascertained; and it was found to be generally lias shale, with a few beds of rock—in some places dry, in others containing a considerable quantity of water.*

In sinking the second working shaft, it was found that a bed of sand and gravel, containing a great quantity of water, lay over part of the tunnel; and this was such a perfect quicksand, that is was impossible to sink through it in the ordinary way. By repeated borings, in various directions near this part of the tunnel, the sand was discovered to be very extensive, and to be in shape like a flat bottomed basin, cropping out on one side of the hill. The trial shafts had accidently been sunk on each side of this basin, so that it had entirely escaped notice until the sinking of the working shaft.

Mr. Stevenson was led to suppose that the water might be pumped out, and that under the water thus drained the tunnel might be formed with comparative facility; this proved to be the case. Engines for pumping were erected, and shafts sunk a little distance out of the line of the tunnel. The pumping was continued nearly nine months before the sand was sufficiently dry to admit of tunnelling, and during a considerable portion of that time the water pumped out was 2,000 gallons per minute. The quicksand extended over about 450 yards of the length of the tunnel, and its bottom dipped to about six feet below the arch.

In May, 1836, one of the large ventilating shafts was commenced, and completed in about twelve months. This shaft is sixty feet in diameter, and 132 feet deep; the walls are perpendicular and three feet thick throughout, the bricks being laid in Roman cement. The second ventilating shaft is not so deep by thirty feet. These immense shafts were all built from the top downwards, by excavating for small portions of the wall at a time, from six to twelve feet in length and ten feet deep.

In November, 1836 a large quantity of water burst suddenly into the tunnel, in a part where there were no pumps; it rose very rapidly, and in order to prevent the ground being loosened by it at the far end, where it was excavated, a rather novel mode of building the brick work was resorted to. This was by forming a large raft, and on this the men and their materials were floated into the tunnel, and with considerable difficulty and danger performed their task.

All the difficulties were at last conquered, and the tunnel finished in October, 1838; but of course the expenses were increased to a very great extent. The directors felt it to be their duty not to restrict the proper outlay of capital, when satisfied it would secure the convenience of the public, the stability of the works, and the efficient management of the traffic; and they felt persuaded that a perseverance in this course, to the completion of the undertaking, would be found most economical in the end, and best calculated to secure the permanency of that successful result which is now hap-

* Organic remains at Kilsby are very numerous. In some parts of the excavation there is hardly a cubic inch without shells and other remains presenting themselves to the eye, and as the earth taken out has been principally laid into spoil, there will be ample opportunities, for some time yet, for further examination, which would well repay either the scientific inquirer or the cabinet collector.

pily placed beyond the reach of doubt. The contract for making the Kilsby Tunnel was 99,000*l.*, and it has cost more than 300,000*l.*, or upwards of 230*l.* per yard.

To give some idea of the magnitude of this work:—There were thirty millions of bricks used in it, which at ten hours for a working day, if a man counted fifty in a minute, would take one thousand days to get through them all. There were above a million of bricks employed in the deepest ventilating shaft, and its weight is 4,034 tons. The weight of the whole tunnel is 118,620 tons; or it would freight four hundred ordinary merchant ships, of about three hundred tons each; and if these bricks were laid end to end they would reach 4,260 miles. The quantity of soil taken from the tunnel was 177,452 cubic yards.

The great ventilating shafts are perfect masterpieces of brickwork, and are found fully to answer the purpose for which they were intended, leaving the tunnel entirely free from any offensive vapor immediately after the transit of each train, and their magnitude can only be estimated by standing in the tunnel and looking upwards.

The passage through this mighty work of engineering skill and ingenuity leaves on the mind, even of those unacquainted with the ordinary difficulties of such an undertaking, a vivid impression of the rare talents of those who designed the work, and superintended its execution. These talents, however, will be more especially appreciated by those who are aware of the many and unforeseen obstacles which arose during its progress.—To Mr. Charles Lean, the assistant engineer under whose direction it was completed, great credit is due for his skill and unremitting exertions, and for the great care he bestowed upon the men in the arduous and dangerous duties in which they were constantly engaged. * * * *

The history of the great railway between London and Birmingham is now finished. A wonderful work it is to look upon, whether it be contemplated in its magnitude and difficulties, its science and capital, or its utility and results. It stands as much the monument of this age as any of the great works of antiquity that have been the subjects of the world's history. There is however, this difference in its favor, that while they have been raised in the cruel exercise of despotic power, and have mainly subserved the purpose of personal vanity, this has been accomplished by the profitable employment of the redundant capital of a single district, to meet the wants of a vastly improved people, and is the triumphant invention of science, trained and disciplined under severe study and gathering accelerated strength from the successful experiments of each succeeding year. The flexible power of steam was indeed known to the philosophers of former times; but they used this knowledge only for the fantastic purposes of caprice and amusement. Anthemius, in the age of Justinian, employed his acquaintance with this principal to annoy a troublesome neighbor, and by imitating an earthquake frightened Zeno out of his house; and at an after period, Pope Sylvester invented an organ, which was set in motion and worked by it. It is the glory of the present era, that science and utility go hand in hand to advance the improvement and happiness of the nation.

Every age of the world has furnished its own peculiar inventions, and these have generally been well adapted to the wants that suggested them, and to the condition in which society was at that time placed. It is a subject more than commonly interesting to contemplate genius toiling amidst so many difficulties, and by patient perseverance overcoming all perplexity and opposition. It is perhaps still more interesting to observe it under the trials of its first experiments, amidst the doubts, unbelief and sometimes

jeers, of the multitude, self possessed in the truth of its principle, yet tremulously fearful while lying at the mercy of the thousand contingencies that might thwart or destroy its hopes and expectations. Such was the case with Telford, on the final erection of the famous hanging bridge over the Menai Straits. It is said that his heart sunk as every successive bolt was struck, till overcome with the agony of his feelings, he retired to his cottage hard by and awaited on his knees the result. The shouts of the admiring populace, when the wonderful fabric settled into its place across the turbulent waters, and his own almost inarticulate thanksgiving in his secret chamber, arose together in the triumph of that hour.

When poor Henry Bell, after years of thought, labor and experiment, first pushed his steam vessel on the Clyde, it was done amidst the scoffs and evil surmises of those who assembled to witness the scene. The inventor died in poverty; but an obelisk that rears itself on the banks of that fine river, near Dunglass, attests the tardy, and to him almost useless, gratitude of his countrymen. Fulton embarked on the Hudson with the same contemptuous greetings and prognostications, from the very people who assembled in thousands to hail the arrival of the Great Western and Sirius steamers across the vast Atlantic, to their own shores. He lived to see, and in some degree to share, the complete sccess of his genius and mechanical skill.* How deeply we are indebted to these children of science who carried forward their discoveries—in the benefits of which we so largely participate—almost broken hearted, amidst the chilling indifference or the withering contempt of a selfish world!

The work of which we have been treating has involved nearly, if not altogether, a capital of six millions of money in its completion. This enormous amount will require three hundred thousand pounds per annum, merely to pay its interest, at five per cent., besides a very considerable sum in addition, to defray the wear and tear, and other expenses of its yearly operations; and yet with all this immense outlay, it is certain, from the host of travellers it will allure into a state of locomotion from pleasure or profit and the various lines that will eventually flow into it, that it will be one of the most productive railways in the kingdom. We cannot, indeed, clearly foresee the end of such an invention, of which this is one of the greatest experiments, or the condition of society it may ultimately produce; but we are warranted in believing that this onward state of improvement, by facilitating and enlarging the sphere of social communication, will tend greatly to increase the amount of social happiness; and in its combining and assimilating influences over the great human family, will assist in bringing about the benevolent purposes of Him, "who hath made of one blood all nations of men for to dwell on all the face of the earth."

THE IRON TRADE.

"ON THE STATE AND PROSPECTS OF THE IRON TRADE IN SCOTLAND AND SOUTH WALES, IN MAY, 1839," WAS READ BEFORE THE LIVERPOOL POLYTECHNIC SOCIETY, ON THE 13TH OF JUNE, BY JOSEPH JOHNSON, ESQ., IRON MERCHANT, LIVERPOOL.

The vast and increasing importance of the iron trade to this country must be so apparant to the most indifferent observer, that I feel fully persuaded I need offer no apology to you for intruding upon your notice the consideration of a subject that appears, at first sight, so completely without the legitimate sphere of the objects for the promotion of which this society was

* The engine used by Fulton, in his first steam boat on the Hudson river, was made by Messrs. Boulton and Watt, of Soho.

established. The daily increasing magnitude of this branch of British industry is surprisingly great; but to enable you to obtain a clear view of its rapid extension, I have extracted from Dr. Ure's valuable "Dictionary of Arts, Manufactures and Mines," the following sketch of its progression from 1740 to 1826. The Doctor observes, p. 687, that, "Till 1740, the smelting of iron ore in England was executed entirely with wood charcoal, and ores employed were principally brown and red hematites. Earthy iron ores were also smelted; but it does not appear that the clay ironstones of the coal basins were then used, though they constitute almost the sole smelting material of the present day. At that era there were 59 blast furnaces, whose annual product was 17,350 tons of cast-iron—that is for each furnace, 294 tons per annum, and $5\frac{1}{8}$ tons per week. By the year 1788 several attempts had been made to reduce iron ore with coked coal; and there remained only twenty-four charcoal blast furnaces, which produced altogether 13,000 tons of cast-iron in the year, being at the rate of 546 tons for each per annum, or nearly 11 tons per week. This remarkable increase of 11 tons for $5\frac{1}{8}$ was due chiefly to the substitution of cylinder blowing machines, worked with pistons, for the common wooden bellows.

"Already 53 blast furnaces, fired with coke, were in activity, which furnished *in toto* 48,800 tons of iron in a year, and which raises the annual product of each furnace to 907 tons, and the weekly product to about $17\frac{1}{2}$ tons. The quantity of cast iron produced that year (1788) by means of coal was 48,800 tons, and that by wood charcoal was 13,100, constituting a total quantity of 61,900.

"In 1796, the wood charcoal process was almost entirely given up, when the returns of the iron-trade, made by desire of Mr. Pitt, for establishing taxes on the manufacture, afforded the following results:—121 blast-furnaces, furnishing in the whole per annum 124,879 tons, giving an average amount of each furnace of 1,032 tons.

"In 1802, Great Britain possessed 168 blast-furnaces, yielding a product of about 170,000 tons, and this product amounted, in 1806, to 250,000 tons, derived from 227 coke furnaces, of which only 159 were in activity at once.

"In 1820, the make of iron had risen to 400,000 tons, and in 1826 to about 600,000 tons.

"From 1823 to 1839 the iron-trade saw many fluctuations. The price of forge pig-iron varying from 2*l.* 10*s.* to 10*l.* per ton at the works. But the make of this country was still increasing, and, in 1838, I believe it reached upwards of 1,000,000 tons."

For many interesting particulars connected with the iron trade of the United Kingdom, and particularly for a detailed account of the introduction of the heated air-blast, by Mr. Neilson, of Glasgow, I must refer you to the excellent work from which I have made the foregoing extracts.

The introduction of the hot-blast formed quite a new era in the iron trade, and the consequent increase of produce of iron, particularly in Scotland, where this invention was first applied, has been incredibly great, and is still progressing. I have been very kindly furnished by a friend, who is intimately connected with the Scotch iron trade, with a list of all the furnaces now in operation in Scotland, the number out of blast, the number erecting, and about to be erected; I have every confidence in the accuracy of my friend's information, and have no doubt but that the correctness of the list may be relied upon. This list shows that there are in Scotland fifty furnaces in blast, five out, seven building, and twenty-six contemplated. With the permission of the meeting, I will read over the names of the works, and their respective owners.

Names of Works.	Owners.	In Blast.	Out of Blast.	Building.	Contemplated.
Clyde	James Dunlop	4	1	—	4
Calder	W. Dixon and Co.	6	—	—	—
Carron	Carron Company	4	1	—	—
Muirkirk	Muirkirk Iron Co.	2	—	—	—
Devon	Devon Iron Co.	2	1	—	—
Shotts	Shott's Iron Co.	2	—	1	—
Monkland	Monkland Iron Co.	5	—	—	—
Gartsherrie	W. Baird and Co.	7	—	1	6
Dundyvan	Dunlop and Co.	5	—	1	4
Summerlee	Wilsons and Co.	4	—	—	2
Castle-hill	Shott's Iron Co.	2	—	—	—
Bona	Bona Iron Co.	1	—	—	—
Govan	W. Dixon, Esq.	2	—	—	4
Wilsontown	W. Dixon, Esq.	1	—	—	—
Coltness	Mr. Holdsworth	2	—	—	—
Omoa	W. Young	1	—	—	—
Carnbroe	Allson and Co.	—	—	2	4
Galston	M'Callam and Co.	—	1	—	—
Blair	Mr. J. M'Donald	—	—	2	—
Housle	Mr. Galloway	—	1	—	2
		50	5	7	26

Supposing the whole of these furnaces to be in full activity by the end of the year 1842, and giving the average produce of eighty tons per week to each furnace, we shall have Scotland alone producing upwards of 360,000 tons of cast-iron per year, nearly equaling the make of the United Kingdom 20 years ago. Sixty-five out of eighty-seven furnaces I have enumerated, are situated in or about the Monklands, to the south and south-east of Glasgow, and distant from that city seven to ten miles. The works in that district have the command of the blackband ironstone, the possession of which my informant states to be so great an advantage, that without it, the trade would not be worth following. The furnaces in the Monklands, by using this combustible blackband ironstone, may average 100 tons in seven days each but those which have not this material, do not yield nearly so large a quantity. Therefore, bearing in mind that the Presbyterians stop their furnaces one shift, or nearly twelve hours on each Sunday, we may safely put down the average yield of the furnaces in Scotland at 80 tons per week each.

Three of the largest makers of iron in Scotland are directing their attention to the manufacture of bar-iron, and with every prospect of most complete success. The Monkland Iron Company are erecting mills and forges capable of making 230 tons malleable iron per week. Dunlop, Wilson and Co., of Dundyvon, are making preparations to enable them, when in full operation, to make 300 tons of bars, &c., weekly, and they will be partially at work in two months. William Dixon, Esq., of Govan Iron Works, has now ready for immediate working, capabilities for producing 200 tons of malleable iron per week. His mills and forges are on the outskirts of Glasgow, and are known as the Glasgow Iron Works, at the Town Head.

The Muirkirk Iron Company have five puddling furnaces, rolling mill, &c., but they are not making more than about 20 tons of bars weekly.

This statement comprises the present, and so far as is known, the prospective operations in the malleable iron trade in Scotland, with the exception of two small forges, the Lancefield and the Gartness, where they puddle a little from white iron.

It was for a long time considered doubtful whether the Scotch cast-iron, made as it is with raw bituminous coal and heated air, would answer for malleable iron, and several experiments have lately been made with a view to ascertain more nearly than had hitherto been done its applicability for this purpose. So far as I have been able to learn, these experiments have been attended with most satisfactory results. I was informed a few days ago by Edmund Buckley, Esq., of Manchester, who has for a long time past taken a very lively interest in these matters, that in some trials recently made by Messrs. Beecroft, Butler and Co., at their works, at Kirkstall, near Leeds, they found 4 cwt. 2 qrs. of Scotch pig-iron to yield, by the process of boiling instead of puddling, blooms of 4 cwt. 1 qr. 8 lbs. each, showing only the comparatively trifling waste of 20 lbs. in a charge of 4 cwt. 2 qrs., and the quality of the iron was found to be at least equal to any made with cold air. Indeed, many thousand tons of Scotch cast-iron have been purchased from time to time by the iron masters of South Wales to mix with their own country metal in their puddling furnaces, thus affording unquestionable proof of its fitness for conversion into malleable iron. I have no doubt that we may speedily receive extensive supplies of bar-iron from Scotland, such as we have hitherto received principally from South Wales and Staffordshire.

I must now ask your indulgent attention for a little while longer, and request the favor of your company on a very interesting tour through the mineral districts of the counties of Gloucester, Monmouth, and Glamorgan. I class the iron works of the Forest of Dean with those of South Wales, as well from their proximity to the latter, as from the circumstances of their being worked by those eminent South Wales iron masters, Messrs Guest, Lewis and Co., and W. Crawshay and Sons. At the "Cinderford" works there are four furnaces, three in blast, and one out, producing on an average from 100 to 120 tons each of excellent forge pig iron weekly. At the "Sewdley" works there are two furnaces, one in and one out of blast, producing about ninety tons of iron per week; and at the Park-end works there are two furnaces, one in blast and the other out, making about eighty tons per week.

The differences in the produce of furnaces may be accounted for in a variety of ways: some are larger than others, some have superior blowing engines and others may be under better management. The furnaces I have named are all that are on the Forest of Dean; but large quantities of iron ore are raised here, and are sent, as well as the iron, to different works in South Wales and Staffordshire. The shipments are made at a wharf a little below Newnham.

Leaving the forest we will proceed to Newport. Here you will find a most excellent river navigation—the Usk; and at all seasons of the year may be seen large numbers of vessels, of various tonnage, waiting to receive the mineral produce of Monmouthshire, in the shapes of coal and iron. Having viewed the port, and noted all its facilities for shipment, and especially the magnificient dock now constructing for affording to the shipping increased conveniences, we will, if you please, proceed to the interior of the county and notice the various works in the order in which we reach them.

The first works we arrive at are those of Capel Hanbury Leigh Esq., near Pontypool, and are called the Pontypool Iron Works. Here you will find three furnaces in blast, and one out; two blown with cold air, and one with hot. There are not any furnaces erecting, or about to be erected here. The make of these three furnaces is about 300 tons per week. The hot air pigs are sold chiefly for foundry purposes, and the cold air iron is used

by Mr. Leigh for tin plates, of which he has been for a long time past a very eminent maker. The yield of the iron stone at these works is about 30 per cent.; but Mr. Leigh imports large quantities of the richer ores from Lancashire and Cornwall, for the improvement of the quality of his iron.

A little further up the valley we reach the works of the Pentwyn and Golynos Iron Company, where you will find five furnaces all in blast, and one about to be erected; three are blown with hot air, and two with cold. The produce of the five furnaces is about 450 tons per week. They have just completed first rate forges and rolling mills, calculated to make 350 tons of bar and other malleable iron per week. About a mile above these works, you find those of the British Iron Company, at Abersychan. Here are four furnaces in blast, all blown with cold air, and two out of blast.—The four make about 380 tons of pig iron per week, from which they make about 270 tons of malleable iron, and the remainder is made into castings, etc.

We next arrive at the Varteg Iron Company's works, where you will find five furnaces all in blast, four blown with hot and one with cold air.—They produce about 350 tons of pig iron per week, from which they make about 160 tons of bars and rails, about twenty tons of castings for engine uses, &c., and the remainder is sold for foundry purposes.

Pursuing our course for two miles further up this valley, we arive at the works of the Blaenavon Iron Company, where we find five furnaces all in blast, blown with cold air and six others erecting. This mineral property, I am told is one of the best and most valuable in the county of Monmouth, and these works have been long distinguished for the superior strength and general excellence of their iron. These five furnaces produce about 400 tons of cast iron per week, about one-half of which is refined, and part of it made into cable iron, and the remainder is sold for tin plates and foundry work. This company are erecting extensive forges and rolling mills, and will, in a few years, contribute largely to the supply of bar iron and rails.

We have now arrived at the extremity of the first valley, and crossing the mountain, we will descend to Abergavenny. The rolling mills on the left hand side are those of the Garndyrris Iron Company, and have been worked for many years by the late firm of Messrs. Hills and Wheely.—They are now united to the Blaenavon Iron Works, and are carried on by the same company.

By the time we have reached Abergavenny, I strongly suspect that you will feel disposed to enjoy the comforts of a good dinner, an evening walk in that most delightful country, and a refreshing sleep, for all of which gratifications you will here find the most ample provision.

Next morning, after the usual and very necessary preliminaries, we resume our tour, and in about five miles we reach the works of the Clydach Iron Company, at Llanelly. Here are four furnaces at work, and all blown with cold air. They produce about 320 tons of pig iron per week, from which they make about 230 tons of bars, &c., and the remainder is run into castings and ballast iron.

The Nant-y-glo Works, are the next we arrive at, situated as their name imports in the Valley of Coal. Here, some years ago, was expended upwards of 50,000*l.* in attempts to establish a profitable iron work, but without success; and not until the property was purchased by the present talented and enterprising proprietors, Messrs. Joseph and Crawshay Bailey, was any remuneration realised. These works now rank amongst the very first class. Messrs. Baily have, within the last few years, purchased the Beaufort Iron works. At the two establishments they have fourteen fur-

naces in blast, ten blown with cold and four with hot air, and I am informed that they intend erecting four others very soon. Their make of pig iron is from 1200 to 1300 tons per week, from which they make about 750 tons bars, rails and rods, and the remainder is sold for foundry purposes.

Near the Nant-y-glo works, and situated in the same valley, are the Coalbrook Vail Company's works, consisting of three furnaces all blown with cold air, and another is about to be erected. The make of the three furnaces is 160 to 180 tons of cast iron per week, all of which they make into castings, or dispose of for that purpose.

A mile lower down this valley you reach the Blaina and Cwm Celyn Iron Company's iron works. These two properties have recently been purchased by a joint stock company, and promise well for their proprietors.—Messrs. Russell and Browns, the former proprietors, are the managing directors. At Blaina they have two furnaces in blast, and one about to be erected, all blown with cold air. They yield about 120 tons of pig iron per week, which is nearly all made into castings on the spot. At Cwm Celyn they are building four furnaces, the entire produce of which is to be made into malleable iron.

We have now finished our inspection of the works in the second valley, and will proceed to the third, which is called Ebbw Vale, from the river Ebbw flowing through it.

(To be continued.)

Railroad Reports.—The following communication, in relation to the publication of railroad reports by Engineers, of *uniform size and style*, as proposed by the publishers of this Journal, is given with a view of calling attention to the subject, and of soliciting the co-operation of the profession in carrying it into practice. It is to be regretted that the plan had not been adopted at an earlier day. It is not, however, as our correspondent says "too late" even now, to adopt it—certainly not as difficult as it would be to adopt a *uniform width of track*, a measure which was urged by us when there was not *half-a-dozen* railroads in use in the United States; with little effect however, as will be seen on examining the numerous reports to be found in the Journal.

For the American Railroad Journal and Mechanics' Magazine.]

Gentlemen:—I perceive by an advertisement on the cover of the last number of your Journal, that you have it in contemplation to publish *extra copies* of railroad reports, which you may be employed to print for railroad Companies and Engineers, as well as of those which you may publish from time to time in the Railroad Journal, of uniform size, that they may be bound up in a volume corresponding with the Journal. I am pleased with the plan, as it will enable Engineers and others, to possess many Reports, in a convenient form for reference; and I regret exceedingly, that you had not, long ago, adopted the measure, as in that case, you would now have been in possession of documents, in a separate form, of great value to the profession. It is not, however, too late now to adopt it; and I hope you will be employed by all Engineers and Companies that can *send* and *receive* their Reports without too much trouble; as I am confident that by so doing, they will aid in the collection and preservation of much important information, in the most convenient form for use, and at the same time give

a lifting hand to the Journal, without incurring additional expense to themselves. You would, I think, do well to place the subject fairly before your readers, and urge upon them with some earnestness, the propriety of aiding you in carrying out your proposition.

Yours, truly, D.

Harlem Railroad.—The receipts on this road for the month of November are as follows:

Nov. 1st to 30th, inclusive,	1839,	7083 98
Nov. 1st to 30th,	1838,	4436 18

showing an increase in the last month over the corresponding month of last year of $2647 80, equal to 59 3-4 per cent. increase.

The number of passengers taken on the road between the city hall and 15th street, who paid sixpence only, were, for the last five months, 247,732 persons.

The receipts on this road for the last quarter, ending the 30th Nov. are as follows:

In September,	1838	$8,770 80	in 1839	$12,881 48
" October	"	7,846 85	"	11,501 87
" November	"	4,436 18	"	7,083 98
		$21,053 83		$31,467 33

showing an increase over the corresponding quarter of last year of $10,-403 50, equal to 494 per cent. and at the rate of 41,614 00 per annum.

The total receipts for fare for the year ending on the 1st of May, 1839 were $79,794 74, while the receipts of the last seven months are $77,673-34, being within $2,122 40 of as much as was received on the whole of last year, from May 1st 1838 to the 1st of May 1839.

This company are now conveying more than one million two hundred thousand passengers per annum on a railroad constructed by them and kept in order at their expense, from which it is obvious that a great saving accrues to the City treasury, inasmuch as the same number of passengers conveyed in carriages, would subject the City to an increased expenditure to keep in repair the pavements over which they would travel.

THEORY OF THE STEAM-ENGINE.

CHAPTER III.—OF THE LAWS WHICH REGULATE THE MECHANICAL ACTION OF THE STEAM.

(Continued from page 319.)

Section III.—Relation between the relative volumes, the pressures and the temperatures, in the steam in contact or not in contact with the liquid.

As it has just been observed, neither Boyle's law nor that of Gay-Lussac can apply alone to changes which take place in the steam remaining in contact with the liquid. But it is clear that from the two, a third relation may be deduced, whereby to determine the variations of volume which take place in the steam, by virtue of a simultaneous change in the temperature and in the pressure; and this relation may then comprehend the case of the steam in contact with the liquid, since it will suffice to introduce into the formulæ the pressures and temperatures which, in this state of the steam, correspond to each other.

Suppose then it be required to know the volume occupied by a given weight of steam, which passes from the pressure p' and temperature t', to

the pressure p and temperature t. It may be supposed that the steam passes first from the pressure p' to the pressure p without changing its temperature, which, from Boyle's law, will give between the relative volumes of the steam, the analogy

$$\mu'' = \mu' \frac{p'}{p};$$

then supposing this steam to pass from the temperature t' to the temperature t, without changing its pressure, the relative volume of the steam, from the law of Gay-Lussac, will become

$$\mu = \mu'' \frac{1 + \cdot 00202\,(t - 32)}{1 + \cdot 00202\,(t' - 32)} =$$

$$= \mu' \frac{p'}{p} \cdot \frac{1 + \cdot 00202\,(t - 32)}{1 + \cdot 00202\,(t' - 32)}.$$

This formula will then express the law according to which the relative volume of the steam changes, by virtue of a given combination of pressure and temperature. Consequently, substituting in this equation for p and t, p' and t', the pressures and temperatures only which correspond to each other in the steam in contact with the liquid, we shall have the analogous changes which take place in the relative volume of the steam, when it is not separated from the water which generated it.

On the other hand, it is known by experience, that under the atmospheric pressure, or 14·706 lbs. per square inch, and at the temperature of 212° of Fahrenheit's thermometer, the relative volume of the steam in contact with the liquid is 1700 times that of the water which has produced it. Hence it is easy to conclude the relative volume of the steam at any given pressure p and at the corresponding temperature t. It suffices, in fact, to insert the above values for p', t', and μ', in the general equation obtained above, and the result will be

$$\mu = 1700 \times \frac{14 \cdot 706}{p} \times \frac{1 + \cdot 00202\,(t - 32)}{1 + \cdot 00202 \times 180} =$$

$$= 18329\, \frac{1 + \cdot 00202\,(t - 32)}{p}.$$

Thus we may, by means of this formula, calculate the relative volume of the steam generated under a given pressure, as soon as we know the temperature answering to that pressure in steam at the maximum of density for its temperature.

It is what we have done in the construction of the following table. The second column has been formed by calculating the temperature of the steam at the maximum density, from the formulæ which we have given in the first section of this chapter. Then using this series of temperatures in the formula which precedes, we have concluded the third column, or the relative volumes of the steam in contact with the liquid, under all the pressures comprised between 1 and 8 atmospheres. This table will, in consequence, dispense from all calculation with regard either to the research of the temperatures, or to that of the relative volumes of the steam; and its extent will suffice for all applications that occur in the working of steam engines.

When we speak of steam *generated* under a given pressure, we understand the steam considered at the moment of its generation, and consequently still in contact with the liquid. We have explained elsewhere that the volume of the steam, compared to that of the water which has produced it, is precisely what we call the *relative* volume of the steam.

Table of the volume of the steam generated under different pressures, compared to the volume of the water that has produced it.

Total pressure, in English pounds, per sq. inch.	Corresponding temperature by Fahrenheit's thermometer.	Vol. of steam compared to the vol. of water that has produced it.	Total pressure, in English pounds, per sq. inch.	Corresponding temperature by Fahrenheit's thermometer.	Vol. of steam compared to the vol. of water that has produced it.
1	102·9	20954	56	289·6	498
2	126·1	10907	57	290·7	490
3	141·0	7455	58	291·9	482
4	152·3	5695	59	293·0	474
5	161·4	4624	60	294·1	467
6	169·2	3901	61	294·9	460
7	176·0	3380	62	295·9	453
8	182·0	2985	63	297·0	447
9	187·4	2676	64	298·1	440
10	192·4	2427	65	299·1	434
11	197·0	2222	66	300·1	428
12	201·3	2050	67	301·2	422
13	205·3	1903	68	302·2	417
14	209·0	1777	69	303·2	411
15	213·0	1669	70	304·2	406
16	216·4	1572	71	305·1	401
17	219·6	1487	72	306·1	396
18	222·6	1410	73	307·1	391
19	225·6	1342	74	308·0	386
20	228·3	1280	75	308·9	381
21	231·0	1224	76	309·9	377
22	233·6	1172	77	310·8	372
23	236·1	1125	78	311·7	368
24	238·4	1082	79	312·6	364
25	240·7	1042	80	313·5	359
26	243·0	1005	81	314·3	355
27	245·1	971	82	315·2	351
28	247·2	939	83	316·1	348
29	249·2	909	84	316·9	344
30	251·2	882	85	317·8	340
31	253·1	855	86	318·6	337
32	255·0	831	87	319·4	333
33	256·8	808	88	320·3	330
34	258·6	786	89	321·1	326
35	260·3	765	90	321·9	323
36	262·0	746	91	322·7	320
37	263·7	727	92	323·5	317
38	265·3	710	93	324·3	313
39	266·9	693	94	325·0	310
40	268·4	677	95	325·8	307
41	269·9	662	96	326·6	305
42	271·4	647	97	327·3	302
43	272·9	634	98	328·1	299
44	274·3	620	99	328·8	296
45	275·7	608	100	329·6	293
46	277·1	596	105	333·2	281
47	278·4	584	120	343·3	249
48	279·7	573	135	352·4	224
49	281·0	562	150	360·8	203
50	282·3	552	165	368·5	187
51	283·6	542	180	375·6	173
52	284·8	532	195	382·3	161
53	286·0	523	210	388·6	150
54	287·2	514	225	394·6	141
55	288·4	506	240	400·2	133

Section IV.—Direct relation between the relative volumes and the pressures, in the steam in contact with the liquid.

It has just been seen, from the formulæ given in the preceding section, that the density and the relative volume of the steam, whether separated from the liquid or not, are known in terms of the simultaneous pressure and temperature. It is likewise known that in the steam in contact with the liquid, the temperature depends immediately on the pressure. It should therefore be possible to find a relation proper to determine directly the relative volume of the steam in contact with the liquid, or, in other words, of the steam at the maximum density and pressure for its temperature, by means of the sole knowledge of the pressure under which it is formed.

The equation which gives the relative volume of the steam in any state whatever, in terms of its pressure and temperature, has been given above. We have also shown the formulæ which serve to find the temperature in terms of the pressure, in steam in contact with the liquid. Eliminating then the temperature from the equation of the volumes and that of the temperatures, we shall obtain definitely the relation sought, or the relative volume of the steam at the maximum density, in terms of the pressure only.

But here starts the difficulty. First, Mr. Biot's formula not being soluble with reference to the temperature, does not admit the necessary elimination. In the next place, the assemblage of the three formulæ reported above, which are made to succeed each other, suit very well in the formation of tables of correspondence between the pressures and the temperatures, when that is the end proposed. Likewise, in an inquiry relative to the expansion of the steam in an engine, when it is known precisely within what limi s of pressure that expansion will take place, it may immediately be discerned which of the three formulæ is applicable to the case to be considered, and then t may be eliminated between that formula and the equation of volumes. But if the question regards, for instance, the case wherein the steam generated in the boiler under a pressure of 8 or 10 atmospheres, might, according to the circumstances of the motion, expand during its action in the engine, either to a pressure less than 1 atmosphere, or to a pressure between 1 and 4 atmospheres, or in fine to a pressure superior to 4 atmospheres; then we shall not know which of the three formulæ to use in the elimination, and it will be impossible to arrive at a general equation representing the effect of the engine in all cases.

Besides, were we even to adopt any one of those equations, the radicals they contain would render the calculation so complicated as to make it unfit for practical applications.

The equations of temperature hitherto known cannot then solve the question that presents itself, that is to say, satisfy the wants of the calculation of steam-engines in this respect; and, consequently, the only means left is to seek, in a direct manner, an approximate relation, proper to give immediately the relative volume of the steam at the maximum density in terms of the pressure alone.

With this view Mr. Navier had proposed the expression:

$$\mu = \frac{1000}{\cdot 09 + \cdot 0000484\, p},$$

in which μ is the *relative* volume, or the ratio of the volume of the steam to that occupied by the same weight of water, and p the pressure expressed in kilograms per square metre. But this formula, though exact enough in high pressures, deviates considerably from experience in pressures below that of the atmosphere, which, however, come under consideration in condensing engines. Moreover, for non-condensing engines, it is possible to

find one much more exact, as it will presently be seen. We deem it then proper to propose, on this subject, the following formulæ :

Formula for *condensing engines* of various systems ;

$$\mu = \frac{10000}{\cdot 4227 + \cdot 00258\, p.}$$

Formula for *non-condensing engines ;*

$$\mu = \frac{10000}{1\cdot 421 + \cdot 0023\, p.}$$

In these formulæ, the pressure p is expressed in pounds per square foot.

The former of the two suits equally to pressures superior or inferior to that of the atmosphere, at least within the limits that it may occur to consider in applying them to steam-engines.

We know that the greatest pressure used in the boiler never surpasses 8 atmospheres, or 120 lbs. per square inch ; and on the other hand, that it can, in no case, be required to calculate the effects of steam acting as a moving force in an engine, at a pressure inferior to 8 or 10 lbs. per square inch, or about $\frac{2}{3}$ of an atmosphere. In a condensing engine, for instance, the steam, after the communication with the condenser has been opened, never descends into the cylinder at a pressure less than 4 lbs. per square inch; the friction of the engine, besides, may be estimated at 1 lb. per square inch ; and it is impossible to suppose a load which shall not, of itself and with the additional friction it occasions in the engine, produce a resistance against the piston of at least 3 lbs. per square inch. Thus the resistance to be overcome by force of the steam, cannot in any case be less than 8 lbs. per square inch ; consequently the steam cannot descend into the cylinder at a pressure less than 8 lbs. per square inch. A formula which gives the exact volumes down to that pressure, is then all that can be necessary for the calculations that may occur, and we shall presently see that the proposed formula fulfils that condition.

The first of the formulæ might also, without any noticeable error, be applied to non-condensing engines. Since, however, in these the steam can hardly be spent at a total pressure less than two atmospheres, by reason of the atmospheric pressure, the friction of the engine and the resistance of the load, it is needless to require of the formula exact volumes for pressures less than 2 atmospheres. In this case, then, the second formula will be found to have a greater degree of accuracy, and we shall in consequence prefer it.

It will be remarked that, besides necessity of these formulæ in the general calculation of the effect of steam-engines, they have the advantage moreover, for other purposes in the arts, of dispensing entirely with tables of temperature, and of supplying the place of tables of the volume of the steam, when these are not at hand.

Finally, to give a precise idea of the approximation given by the two formulæ just mentioned, we here subjoin a table of the values they furnish for the principal points of the scale of pressures.

Relative Volume of the Steam generated under different pressures, calculated by the proposed formulæ.

Total pressure of the steam in pounds per square inch.	Volume of the steam, calculated by the ordinary formulæ.	Volume calculated by the proposed formula for condensing engines.	Volume calculated by the proposed formula for non-condensing engines.
5	4624	4386	"
6	3901	3771	"
7	3380	3307	"
8	2985	2946	"
9	2676	2655	"
10	2427	2417	"
11	2222	2218	"
12	2050	2049	"
13	1903	1904	"
14	1777	1778	"
15	1669	1668	"
20	1280	1273	1243
25	1042	1030	1031
30	882	864	881
35	765	745	768
40	677	654	682
45	608	583	613
50	552	526	556
55	506	479	509
60	467	440	470
65	434	407	436
70	406	378	406
75	381	354	381
80	359	332	358
85	340	312	338
90	323	295	320
105	281	254	276
120	249	222	243
135	224	198	217
150	203	178	196

Section V.—Of the constituent heat of the steam in contact with the liquid.

There is yet an inquiry, relative to the properties of steam, which has long fixed the attention of natural philosophers: it is that of the quantity of heat, necessary to constitute the steam in the state of an elastic fluid under various degrees of elasticity.

It is well known that when water is evaporated under the atmospheric pressure, in vain new quantities of heat may be added by means of the furnace, neither the temperature of the water, nor that of the steam ever rise above 100° of the centigrade thermometer, or 212° of Fahrenheit. All the heat then which is incessantly added to the liquid must pass into the steam, but must subsist there in a certain state which is called *latent*, because the heat, though really transmitted by the fire, remains nevertheless without any effect upon the thermometer, nor does it afterwards become perceptible till the moment of disengaging itself, on the steam being condensed.

This latent heat evidently serves to maintain the molecules of water in the degree of separation suitable to their new state of elastic fluid; and it is then absorbed by the steam, in a manner similar to that which is absorbed by the water, on passing from the solid state, or state of ice, to the liquid.

But it is important to know the quantity of the latent heat, in order to appreciate with accuracy the modifications the steam may undergo.

Some essays made by Watt had already elicited, that the steam, at the moment of its generation, or in contact with the liquid, contains the same quantity of total heat, at whatever degree of tension, or, in other words, at whatever degree of density it may be formed. The experiments of Messrs. Sharpe and Clement have since confirmed this result. From them is deduced, that the quantity of latent heat contained in the steam in contact with the liquid, is less and less, in proportion as the temperature is higher; so that the total heat, or the sum of the latent heat plus the heat indicated by the thermometer, form in all cases a constant quantity represented by 650° of the centigrade thermometer, or, 1170° of Fahrenheit's.

Southern, on the contrary, has concluded from some experiments on the pressure and temperature of steam, that it is the latent heat which is constant; and that, to have the total quantity of heat actually contained in steam formed at a given temperature, that temperature must be augmented by a constant number, representing the latent heat absorbed by the steam in its change of state.

Some authors have deemed this opinion more rational, but the observations we are about to report seem to us to set the former beyond all doubt.

It is known, that when an elastic fluid dilates itself into a larger space, the dilatation is invariably attended with a diminution of temperature. If, then, the former of the two laws is exact, it follows that the steam, once formed at a certain pressure, may be separated from the liquid, and provided it lose no portion of its primitive caloric, by any external agent, it may dilate into greater and greater space, passing at the same time to lower and lower temperatures, without ceasing on that account, to remain at the maximum density for its actual temperature. In effect, since we suppose that the steam has in reality lost no portion of its total heat, the consequence is that it always contains precisely as much as suffices to constitute it in the state of maximum density, as well at the new temperature as at the former.

If, on the contrary, Southern's law be exact, when the steam, once separated from the liquid, will diminish in density as it dilates into a larger space, it will not remain at the maximum density for the new temperature. To admit indeed that it would do so, would be to verify Watt's law, since the new steam would be at the maximum density, although containing precisely the same quantity of total heat as the old. But since we admit, on the contrary, that the primitive steam contained more heat than was necessary to constitute the new at the maximum density, it follows that the surplus heat, now liberated, will diffuse itself into the new steam; and as this is separated from the liquid, the increase of heat cannot have the effect of increasing the density of the steam, but will be altogether sensible in the temperature. Thus the result will be, a steam at a certain density, indicated by the spaces into which it is dilated, and at a temperature higher than what is suitable to that density, in steams at the maximum of density for their temperature.

Now, in a numerous series of experiments of which we shall speak hereafter, we have found that in an engine whose steam-pipes were completely protected against all external refrigeration, the steam was generated at a very high pressure in the boiler; and, after having terminated its action in the engine, escaped into the atmosphere at pressures very low and very varied; and that in every case, the steam issued forth precisely in the state of steam at the maximum of density for its temperature. Southern's law then is inadmissible, unless any one choose to suppose that in these varied changes of pressure, the steam lose, by contact with the very same external

surfaces, always precisely and strictly just that quantity of heat, sometimes very considerable, at other times very small, by which its temperature should have increased. Consequently we regard the law of Watt as the only one supported by the facts.

The total quantity of heat contained in the steam in contact with the liquid, and under any pressure whatever, is then a constant quantity; and according as the sensible heat increases, the latent heat diminishes in an equal quantity.

On the other hand, according to the same law, if we conceive water to be enclosed in a vessel capable of sufficient resistance, and submitted to temperatures of greater and greater intensity; the latent heat of the steam thence arising, will be less and less as the sensible heat or temperature shall become greater; and as soon as the steam shall be generated at a temperature equal to 650° centigrade or 1170 degrees of Fahrenheit, it will cease to absorb heat in a latent state, and will no longer receive any portion of it, but which will be sensible on the thermometer. We must then conclude that at this point the steam will have a density equal to that of water; since in passing from one state to another, it requires no farther increase of caloric, as would be necessary if any farther increase of severance were to take place between the molecules. Thus the water, though still contained in the vessel, will all have passed into the state of steam. From this moment then, new quantities of heat may be applied to the vessel; but instead of acting on a liquid, it will now act only on an elastic fluid, and therefore all the increase of heat which is added, will, as in all gases, become sensible on the thermometer.

This observation explains the difficulty, which would otherwise present itself: viz., that beyond 650 degrees centigrade or 1170 of Fahrenheit, the preceding law could not subsist without the latent heat becoming a negative quantity, which had been the cause of this law being rejected by some authors.

(To be continued.)

IMPORTANT INVENTION IN THE MANUFACTURE OF PAPER HANGINGS

We were favored a few days since with an opportunity of visiting the extensive paper works of Messrs. J. Evens and Co., at the Alder Mills, near Tamworth, where we had the pleasure of witnessing the application of an ingenious and very beautiful piece of mechanism, the invention of the Messrs. Evens, to the printing of paper hanging, which cannot fail to produce a complete change in this department of our manufactures, from its superiority over the ordinary method of block printing. The Messrs. Evens would have brought their invention into practical operation many years ago, had it not been for the heavy duties imposed on the manufacture of stained papers, which by limiting the consumption, rendered their invention comparatively useless, a fact which supplies another argument against the imposition of heavy duties upon the manufacturing skill and industry of the country. In connection with the present invention, we may here state that the Messrs. Evens took out a patent in February last, for an important improvement in the manufacture of paper, by the application of a pneumatic pump in the compression of the moisture from the pulp, by which means the substance is almost instantaneously converted into paper. By this invention they are, we understand, enabled to manufacture a continuous sheet of paper six feet in width, and nearly 2,000 yards in length every hour. This paper, as it is taken off the reel, is in every respect fit for immediate use, and is conveyed on rollers to another part of the mill, in which the printing machinery is erected, through which it is passed with great rapid-

ity, and receives the impression of the pattern intended to be produced, with all the precision and beauty of finish which machinery can alone effect. In order to connect the operations of the paper making and printing machines the Messrs. Evens are at present engaged enlarging their premises, and when this alteration is completed they will be enabled to print, glaze, and emboss, the most complicated and delicate pattern in paper hangings, in every variety of shade or color, as rapidly as the paper can be manufactured. Some idea may be formed of the power of the machinery, and the importance of the invention, when we state that during our visit to the mill, the machinery was working at a rate which would produce 1,680 yards of paper per hour, consisting of two very beautiful patterns, the only hand labor employed being that of one man, who superintended the machinery, and four girls, employed in rolling up the paper in pieces of the required length. The whole process of manufacturing the paper from the pulp and impressing it with the most complicated pattern, is carried on within a comparatively small space, and with a precision and rapidity which affords another instance of the progress and triumph of science and mechanical skill, in supplying the necessaries and comforts of civilized life. We understand it is the intention of Messrs. Evens to exhibit some specimens of their beautiful manufacture at the forthcoming meeting of the British Assocation, and we feel confident that amongst the many objects of interest which the mechanical skill and industry of Birmingham afford, the present will excite not the least interest or gratification. We may, perhaps, here observe, that the Messrs Evens have also executed a very ingenious design of an envelope, which seems admirably adapted for meeting the views of government in the contemplated change about to be made by the adoption of Mr. Rowland Hill's plan of a uniform penny postage. Specimens of this design have been forwarded to the Chancellor of the Exchequer for examination, and from the security which it affords against any successful attempt at forgery there appears great probability that it will be in part if not wholly adopted.—*Midland Counties Herald.*

Draining of Land by Steam Power.—The draining of land by steam power has been extensively adopted in the fens of Lincolnshire, Cambridgeshire, and Bedfordshire, and with immense anvantage. A steam engine of 10 horse power has been found sufficient to drain a district comprising 1,000 acres of land, and the water can always be kept down to any given distance below the plants. If rain fall in excess, the water is thrown off by the engine; if the weather is dry, the sluices can be opened, and water let in from the river. The engines are required to work four months out of the twelve, at intervals varying with the season, where the districts are large; the expense of drainage by steam power is about 2*s.* 6*d.* per acre. The first cost of the work varies with the different nature of the substrata, but generally it amounts to 20*s.* per acre for the machinery and buildings. An engine of 40 horse power, and scool wheel for draining, and requisite buildings, costs about 4,000*l.*, and is capable of draining 4,000 acres of land. In many places in the fens, land has been purchased at from 10*l.* to 20*l.* per acre, which has been so much improved by drainage, as to be worth 60*l.* to 70*l.* per acre. The following list shows the number of steam engines employed for this purpose in England: Deeping fen, near Spalding, Lincolnshire, containing 25,000 acres, is drained by two engines of 80 and 60 horse power. March West fen, in Cambridgeshire, containing 3,600 acres, by one engine of 40 horse power. Misserton Moss, with Everton and Graingley Carrs, containing about 6,000 acres, effectually drained by one engine of 40 horse power. Littleport fen, near Ely, about 28,000 acres, drained by two steam engines of 30 or 40 horse power each.

Before steam was used there were 75 wind engines in this district, a few of which are still retained. Middle fen, near Soham, Cambridgeshire, about 7,000 acres, drained by an engine of 60 horse power. Waterbeach level between Ely and Cambridgeshire, containing 5,000 acres by a steam engine of 60 horse power. Magdalen fen, near Lynn, in Norfolk, contains upwards of 4,000 acres, and is completely drained by a steam engine of 40 horse power. March fen district, Cambridge, of 2,700 acres, is kept in the finest possible state of drainage by a 30 horse power engine. Feltwell fen, near Brandon, 2,400 acres, by an engine of 20 horse power. Soham Mere, Cambridgeshire, formerly, (as its name implies,) a lake of 1,600 acres, drained by a 40 horse power engine, the lift at this place being very great.—*Lincoln Paper.*

Railways in Germany.—That part of the Taunus railway which lies between Frankfort and Hochst was opened on the 7th inst. The first train started at five in the morning. The two places, formerly two hours assunder have been brought within a distance of eight minutes of each other. On the same day (the 7th) the Emperor Ferdinand's railway, from Vienna to Brunn a distance of about nineteen German (eighty-five English) miles, was opened with great solemnity. The first train performed the distance in a few minutes over four hours. The day appears to have been celebrated, particularly at Brunn, as a civic feast, and the tickets which had been sold were disposed of by the first purchasers of them at a considerable advance, to those who were anxious to be able to boast that they had been among the first travellers by the new railway. We regret to find that the day did not pass over without an accident. In the evening, as one of the returning trains had stopped at a station to take in water, the locomotive engine of the train next in succession ran into the hindermost carriage, by which means several persons were seriously hurt, though none dangerously. The engineer, to whose carelessness the accident was attributed, was immediately placed under arrest.

Manchester and Birmingham Railway.—The viaduct across the valley at Stockport, one of the heaviest contracts on the line, is now rapidly progressing. This work consists, in part, of 23 arches of 63 feet span. These arches, or rather the centres on which the arches are to be turned, require 3,500 cubic feet of timber for the construction of each, and there are to be eight arches completely finished before the centre of the first is struck. It will therefore, require 30,000 feet of timber in the construction of this part of the work. The brick work is three feet in thickness. The highest arch will overtop Mr. Ferneley's seven story mill about 12 feet.—*Staffordshire Advertiser.*

Liverpool and Manchester Railway.—The fifteenth half-yearly meeting of the shareholders was held on Wednesday, the 24th July. By the balance sheet it appears that the total receipts for the half-year ending the 30th of June, 1839, were 123,814*l.* 6*s.* 8*d.*; the expenses 75,602*l.* 7*s.* 1*d.*; giving a nett profit for the half-year of 48,211*l.* 19*s.* 7*d.*; to which is added 5,089*l.* 15*s.* 8*d.*, balance from the last account, leaving a disposable sum of 53,301*l.* 15*s.* 3*d.* From which sum the directors recommended a dividend of 4*l.* 10*s.* per share, amounting to 49,023*l.* 4*s.* 6*d.*, leaving a balance of 4,278*l.* 10*s.* 9*d.* to be carried to the credit of the next half-year's account, which proposition was unanimously agreed to by the proprietors.—*C. E. & A. Journal.*

Description of a new railway wheel, by Mr. Cottam.—The wheels suggested are made on the following principles: 1st. They are wholly of wrought iron, so welded together, that, independent of screws, rivets, or any other kind of fastening, they form one piece with the spokes. 2nd. The spokes of the wheels are placed diagonally, and act as trusses, thereby giving the greatest possible support to the rim, or tire, and at the same time being in the best position for resisting lateral pressure. 3d. Iron in a state of tension or compression, as is usually the case with the tires of wheels, is easily broken by sudden shocks, or by vibratory action. The wheels in question are so constructed, that the fibres of the iron employed are neither compressed nor stretched, but remained in their natural condition. 4th. The strength of iron being as the square of its depth, then the flanged tires of these wheels, which offer sections twice as deep, are consequently four times as strong as those of any wheels at present in use. This increase of strength is attributable solely to the peculiarity of their construction, and not to any increase in the weight of the material. 5th. The spokes strike the air edgewise, and thus offer the least possible resistance. Wheels where the spokes present a flat surface may be said to act as blowing machines, and, as such, require greater propelling power. 6th. These wheels by simply varying the curve of their spokes, become either rigid or flexible, or in other words, they may be made to any degree of elasticity. 7th. When worn by friction, the rims or tires may be turned down, and have hoops of railway tire shrunk on them. Thus repaired, these wheels are very strong and durable, and more advantageous than those of other constructions.

Mr. Roberts spoke to the successful use of cast iron wheels, which, properly manufactured, he had never found to fail. The most important consideration to be attended to was the absence of oxide of iron, and if any was on the metal it must be removed by a file. If this precaution were attended to, there would be little fear for the stability of cast iron wheels. Mr. Woods stated that on the Liverpool and Manchester railway cast iron wheels were much used. They had employed wheels with wooden tires at the opening of that line, some of which were still in use; and so satisfied were the directors, that it was their intention to have some new wooden wheels made, and to submit them to the test of expertment.

Gigantic Tunnel.—Zanino Volta, an Italian engineer, has brought forward a plan for a railway from the lake of Zurich to Como, to join the Lombardo Venetian railway. He proposes to pass the Grison Alps by a long tunnel, which, from his survey, he hopes to be able easily to carry through the granite rocks. M. Volta proposes to form the rails of the granite, which is of a good quality. Two cantons have already given their approbation to the plan, and the engineer hopes to obtain sufficient support to be able to carry it into execution.

Roman Causeway.—Some works for improving the channel of the Scheldt have necessitated several extensive cuttings across the old Roman causeway, called La Chausee de Brunehaut, which connects in a straight line, the towns of Bavay and Tournay. These cuttings took place on the spot described in the itinerary of Antoninus as the Pons Scaldis. In the course of the work there have been discovered, on various points remains of constructions and large quantities of materials, which indicate the scite of a town or large village, and it appears that in this locality several bridges had been thrown over the Scheldt. This discovery shows that the point given by antiquaries as Pons Scaldis, was not merely a bridge over the Scheldt, but a Roman station which was probably fortified.

For the American Railroad Journal, and Mechanics' Magazine.

METEOROLOGICAL RECORD FOR THE MONTHS OF JULY and AUGUST, 1839.

Kept on Red River, below Alexandria, La., (*Lat.* 31.10 *N.*, *Long.*, 91.59 *W.*)

1839	Thermometer.					
Sept.	Morn.	Noon.	Night.	Wind.	Weath.	Remarks.
1	69	87	82	calm	clear	
2	70	84	78	..	cloudy	all day
3	60	87	80	NE	clear	
4	68	88	82	SE	..	
5	68	89	85	..	..	
6	74	82	80	SW	cloudy	light showers at noon and afternoon
7	78	91	86	.. high	clear	all day
8	80	90	79	.. light	cloudy	at 10 a. m. fine shower
9	84	74	74	.. high	..	at 12 shower
10	70	82	76	NW	clear	
11	66	80	72	NE	..	
12	69	82	75	..	..	
13	66	80	73	N	..	
14	62	82	70	calm	..	smoky all day sunshine dim
15	61	84	78	..	..	foggy morning day clear weather smoky sun-
16	67	89	80	SW	..	[shine dim
17	68	89	82	calm	..	
18	70	90	82	..	..	
19	62	85	80	..	..	
20	60	86	80	..	..	
21	62	86	81	..	..	
22	61	87	80	..	..	
23	68	85	79	..	..	
24	69	73	73	SW	cloudy	at noon light showers and distant thunder
25	68	80	76	calm	clear	
26	67	79	76	..	..	
27	70	72	74	NE	cloudy	
28	66	76	74	calm	clear	
29	64	76	72	..	..	
30	62	77	73	NE	..	
	64.5	83	78.7	....	....	mean temp. of the month 75.
Oct.	57	81	78	calm	clear	thick smoky weather
1	58	81	78	..	..	
2	60	82	77	..	..	foggy morning
3	60	81	75	..	..	
4	66	86	81	S	..	
5	71	86	81	SE	..	evening cloudy
6	71	80	78	..	cloudy	light showers in the evening
7	76	84	79	..	clear	
8	74	78	78	E	cloudy	drisling and light showers in forenoon heavy
9	74	74	75	calm	..	all day and light showers [rain at night
10	69	80	74	..	clear	all day
11	66	82	78	..	..	
12	68	82	76	..	..	
13	62	82	76	..	..	
14	62	82	70	..	..	
15	64	78	70	..	..	
16	63	76	70	W	..	
17	57	76	74	..	..	
18	58	77	69	..	..	
19	59	76	78	NE	..	
20	57	74	68	..	..	smoky weather
21	60	78	70	..	..	
22	66	79	74	S	..	
23	67	80	78	..	..	
24	71	84	78	SE	..	
25	70	81	78	calm	cloudy	
26	72	80	75	NE	..	
27	65	75	72	N light	clear	
28	55	70	65	..	..	
29	51	72	64	calm	..	
20	54	75	64	..	..	
31						
	64	79	74	....	....	mean temp. of the month 73.

Engraving on Marble.—Mr. Rayner, of Derby, has made a discovery in art; a new method of engraving on marble. Some of his pictorial efforts have elicted great admiration. Her Majesty is in possession of a variety of specimens, and the nobility in England and France have introduced them into their drawing rooms.